16 State House Station
Augusta, Maine 04333

Transportation Research Division

Technical Report 16-13

Bridge-in-a-Backpack™

Task 5: Guidelines for Quality Assurance

Technical Report Documentation Page

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16. Abstract (Limit 200 words)

This report includes fulfillment of Task 5 of a multi-task contract to further enhance concrete filled FRP tubes, or the Bridge in a Backpack. Task 6 provides guidelines for quality assurance.

The Bridge-in-a-Backpack™ or hybrid composite arch bridge system is a built up from a hollow tubular arch made of fiber reinforced polymer (FRP) composite materials. The tubular arch is combined with concrete on a concrete foundation to create a FRP reinforced concrete arch structure. This structure is combined with other components such as decking, headwalls and then a granular backfill to create a bridge system with long lasting materials. Each project or structure however needs to have quality control measures in place to ensure that quality materials and procedures are used in the construction of this system. This report reviews existing literature and practices to provide recommendations for the Quality Assurance and Quality Control practices used in the procurement of the hybrid composite arch bridge system.

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Bridge-in-a-Backpack^{TM}
Task 5: Guidelines for Quality Assurance

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1 Introduction

The Bridge-in-a-Backpack™ or hybrid composite arch bridge system is a built up from a hollow tubular arch made of fiber reinforced polymer (FRP) composite materials. The tubular arch is combined with concrete on a concrete foundation to create a FRP reinforced concrete arch structure. This structure is combined with other components such as decking, headwalls and then a granular backfill to create a bridge system with long lasting materials. Each project or structure however needs to have quality control measures in place to ensure that quality materials and procedures are used in the construction of this system. This report reviews existing literature and practices to provide recommendations for the Quality Assurance and Quality Control practices used in the procurement of the hybrid composite arch bridge system.

2 Background on FRP Composite Materials

Fiber reinforced polymer composite materials (composites) are seeing increased use in civil infrastructure due to their durability, strength and weight. Composite materials have an almost infinite number configurations requiring understanding of the materials by engineers responsible for their procurement. Composites are made up of layers fiber reinforcement in polymer matrix creating a laminate. In general the fiber or fabric provide the strength and stiffness of the laminate while the matrix provides protection and support for the fibers creating a rigid laminate. There are many types of fibers that can be used, but glass and carbon are the most widely used fibers for composite laminates today. There are several types of resin as well including, but not limited to epoxy, vinyl ester, and polyester; with epoxy generally being the stiffest, strongest, and most durable, and polyester generally being the least expensive.

Laminates can be combined in many shapes, thicknesses, with and without core materials and with or without outer coatings such as gel coats. Completed parts or structures must meet defined quality control standards for use in many applications.

3 Types of Deficiencies

The completed parts or structures must meet quality control requirements. Products that do not meet those requirements have deficiencies that may include one or more of dimensional irregularities, strength or stiffness deficiencies, damage, or durability deficiencies. Each of these is discussed in more detail in the following sections.

3.1 Dimensional Irregularities

Dimensional irregularities may be the simplest deficiencies to identify and quantify. Each arch or component of an arch will be manufactured to indicate tolerances including diameter of the hollow FRP tube and radius of curvature.

There are several sources of error for dimensional errors in the arch geometry and diameter. They can be broken down into two main areas including raw material and formwork errors, and manufacturing errors. Raw material errors could include poor quality of braided materials used in the arches where the diameter of the tube may neck down or bulge. Formwork errors would be caused by errors in the construction of the formwork where the shape of the form is incorrect and the error is missed prior to infusion of the arches. Manufacturing errors occur when all the input materials and formwork are correct but the shape and diameter of the arch are of poor quality. This would be due to several factors including poor tensioning of the arch, improper inflation pressure or other factors causing the arch not to follow the shape of the formwork.

3.2 Strength or Stiffness Deficiencies

Strength or stiffness deficiencies are the result of other deficiencies such as material, dimensional, or manufacturing. As previously stated, the arches are constructed from braided fabric reinforcing and thermoset resin. Tensile strength and stiffness of this laminate are dominated by the fabric, typically braided carbon or glass fibers and deficiencies in the fibers of the fabric could be a cause for strength of stiffness deficiencies. Dimensional deficiencies causing irregular fiber angles could also be a cause of strength or stiffness deficiencies.

3.3 Damage

There are several types of damage that should be considered when inspecting hybrid composite tubular arch bridges or similar structures. Ryan et al [1], recommends the inspection program for FRP will look for: blistering, voids and delaminations, discoloration, wrinkling, fiber exposure, scratches, and cracking. Goslin and Tomlinson [2] presented several types of damage and material deficiencies. These same deficiencies are presented here as some are more noticeable following the manufacturing of the FRP tubular arch and applicable to quality assurance discussions of this report.

3.3.1 Blistering

Ryan et al [1] describes blistering as “surface bubbles” caused by moisture trapped in the laminate during fabrication. Blisters could also form in service with CFFTs due to water movement through cracks and/or freeze/thaw cycling. Hong and Hastak [3] found blisters to be considered as a concern by the Ohio DOT of similar nature to delaminations or voids.

3.3.2 Delamination & Voids

Ryan et al [1] describes voids and delaminations are regions where the FRP shell or layers of the FRP shell have separated from each other. Voids could be present from construction when air pockets form between the concrete and FRP shell. Delaminations could be caused by impact, excessive flexure, or poor quality control during manufacturing. Figure 1 shows a void and resulting surface crack of a foam filled FRP structure. Figure 2 shows a delamination due to a puncture.

Figure 1: Voids resulting in surface cracks (Ryan et al [1])

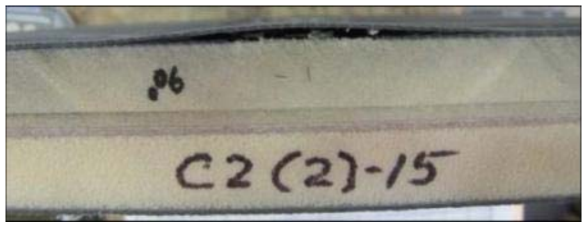

Figure 2: Delamination due to puncture (Kittridge et al [3])

Delaminations may be found with visual or physical examinations. Whitening may be present indicating cracks in the resin/matrix.

3.3.3 Discoloration

Discoloration may be indicative of structural problems. Whitening due to abrasion or excessive strain such as that seen in Figure 3 is detectable with visual inspection and can be minor or severe depending on the level of damage to the fibers.

Figure 3: Discoloration due to abrasion, study samples

As Ryan et al [1] describes, discoloration in FRP composites can also be due to environmental degradation, moisture infiltration, or chemical reactions due to contact with excessive UV, heat, or other chemicals. Previous testing by Demkowicz [4] for the hybrid composite arch bridge technology has shown there to be very little discoloration of the BiaB composite tubes caused by alkali, water, and salt water exposure.

3.3.4 Punctures, Holes, Cracks

According to the **BRIDGE INSPECTOR'S MANUAL** (Ryan et al [1]) punctures, holes, and cracks can result from impact of vehicles, debris such as logs or rocks, or other deficiencies that are left untreated. Full or partial punctures may result in additional cracking and delaminations. A puncture in a BiaB composite CFFT with a puncture can be seen in Figure 4. The damage shown in Figure 4 is quite small, not in a critical location, and therefore not an immediate structural concern, but would need to be sealed with a small surface patch to prevent the ingress of water or chemicals and which could cause future degradation of the FRP.

Figure 4: Full puncture/hole in carbon fiber laminate

3.3.5 Wrinkling

Wrinkling can occur in multiple areas of the FRP. This can occur in the fabric in the lamina itself, which is generally due to fabrication control issues, and is evaluated for acceptance prior to shipment of the FRP tube. Wrinkling can also be due to high compression stresses in a thin composite, which results in buckling of the tows or fibers. While tow buckling is certainly a sign of structural distress, it is highly unlikely that it would occur in a BiaB tube since the concrete carries the vast majority of the compressive stresses. A phenomenon similar in appearance to wrinkling can be the result of a local crease in the bagging film used for infusion as shown in Figure 5, causing a resin ridge as shown in Figure 6. This resin ridge is normal for this type of FRP tube structure and not a structural concern.

Figure 5: Bagging film ridges acceptable in the resin layer of a BiaB FRP tube

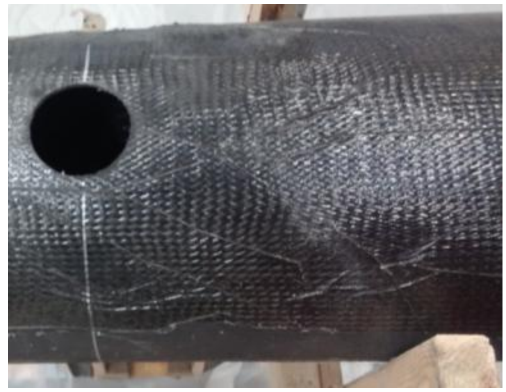

Figure 6: Acceptable resin ridge in the resin layer of a BiaB FRP tube

3.3.6 Fiber Exposure

Fiber exposure often occurs along with other types of damage, such as punctures, abrasion, fire, or scratches and gouges. This is a serious condition due to the significant exposure to fibers and should be remedied. Along with the fiber exposure shown in Figure 1, Figure 3, Figure 4, Figure 8, and Figure 9, fiber exposure due to fire is shown in Figure 7.

Figure 7: Fibers exposed due to fire damage

3.3.7 Scratches or Gouges

Scratches are generally seen in the surface of the FRP laminate and can be minor to severe. Severe scratches could develop into cracks where fibers are damaged or cut and cause structural concerns. Scratches could be caused by improper handling during erection or by vandalism once construction is completed. They will usually be detectable by visual inspection and may also be evident with delamination.

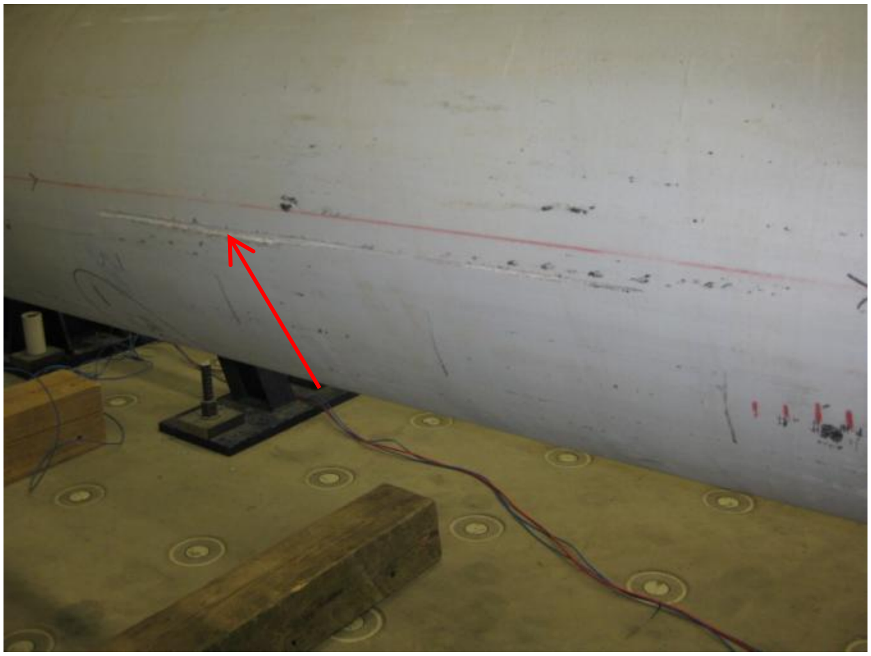

Figure 8: Scratch in FRP pile

3.3.8 Cracks

Cracks can form along with other types of damage, and can lead to fiber exposure. Major cracks should be repaired due to the possibility of decrease of structural capacity or exposure of fibers to damaging conditions. Cracks are shown around a puncture damage area in Figure 9.

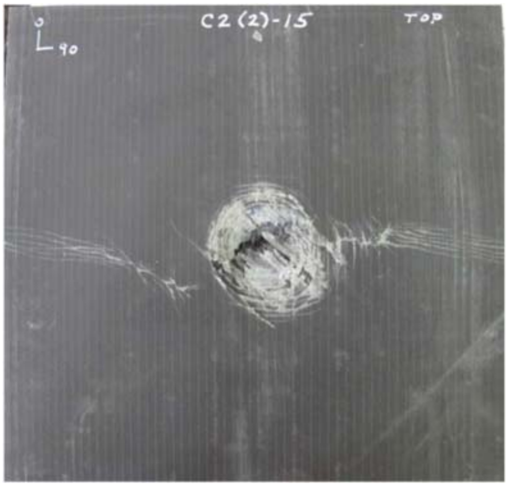

Figure 9: Cracks form around a puncture (Kittridge et al [5])

3.4 Durability

The durability of the composite materials is a main driver for their use. Deficiencies in material durability can have adverse effects on a structure's service life. Manufacturing conditions, material selection and handling can all affect the durability of a composite structure. Testing for the durability of individual structures is time consuming and expensive but baseline testing for material systems can be completed to qualify new materials.

The type of resin plays a critical role in the durability of FRP materials. Fibers in different resins can have dramatically different durability characteristics. Some resin types are prequalified for structural use given their chemical and physical properties and type of resin. Other resins can be qualified for use with durability testing according to Acceptance Criteria 125 (Demkowicz [4] and Tomlinson et al [6]). Prequalified resins include epoxies and vinyl ester resins that meet the requirements of the AASHTO LRFD Guide Specifications for Design of Concrete-Filled FRP Tubes for Flexural and Axial Members [7].

3.5 Voids between the Concrete and Shell or Unfilled Tube Sections

Voids between the concrete and laminate shell can cause significant reductions in the capacity of the composite arch bridge system (Lawrence et al [8]). Voids have been seen in many arches constructed for lab testing as well as bridges. It was generally seen that these voids were caused by inadequate self-consolidating concrete (SCC) mixes when placed in the tubes (Nagy et al [9]). Several specifications and test methods exist and are in use to ensure quality concrete is placed in the arch tubes. These specifications and test methods are presented in Goslin and Clapp [10]. Methods of inspection for voids are beyond the scope of this project but are presented in Goslin and Tomlinson [2].

4 Review of Applicable Standards and Specifications for Quality Assurance of FRP and Other Materials

A great deal of literature has been published in recent years on the use of FRP composite materials for use in structural applications including bridges. Several states have published guidelines for their use including quality assurance standards. Maine DOT Standard Specifications and other pieces of literature as they pertain to required tests for various materials.

4.1 Maine DOT Standard Specifications

The Maine Department of Transportation has quality standards for infrastructure construction including reinforcing steel and concrete used throughout Maine. Materials are specified in the Maine DOT Standard Specifications. The Standard Specifications also requires a Quality Assurance Plan (QAP) including the use of Quality Assurance Inspectors (QCI). Quality Assurance of materials specified is addressed in the QAP including the sample size for quality assurance of each type of material.

4.2 Other Standards Applicable to Quality Assurance of FRP Materials

Several other standards and specifications exist that are applicable to the quality assurance of FRP composites use in transportation infrastructure including bridges. This includes the Florida DOT's Fiber Reinforced Polymer Guidelines (Florida DOT [11]), Quality Assurance and Quality

Control Methods for Resin Infusion (Kenerson [12]) and AASHTO's LRFD Bridge Design Specifications for GFRP-Reinforced Concrete Bridge Decks and Traffic Railings [13].

AASHTO's Guide Specification for GFRP-Reinforced Bridge Decks and Traffic railings describes the use of GFRP use in these types of structures. This includes requirements for quality assurance testing. Sampling requirements are given and are similar to previous standards though with 5 test specimens required to be sampled per lot [13]. These samples are tested similar to steel reinforcing bars as specified in ASTM A615. A production lot size is not defined in this reference.

Florida DOT's Fiber Reinforce Polymer Guidelines [11] allows for the use of vacuum infused structural shapes in Section 6. This section references ASCE's Pre-Standard for LRFD of Pultruded FRP Structures [14] as well as AASHTO's Guide Specification for Design of Concrete-Filled FRP Tubes for Flexural and Axial Members for the design criteria of new structures [7]. In addition this guideline defines the production lot size as each individual vacuum infusion process. In the case of tubular arches that would be each individual arch.

4.3 Comparison with Bridge-in-a-Backpack

The hybrid composite arch bridge system requires similar quality assurance and quality control programs to other structural systems. Standard quality assurance practices are applicable to this technology such as using a Quality Control Plan for each structural component which includes quality assurance testing and inspections during manufacturing and of the finished component.

Quality assurance testing for the hybrid composite arch bridge system is similar to testing other tensile reinforcing products where a test coupon is taken from the finished part or lot and tension tests are performed. However, differences exist in the level of preparation required to acquire good test samples. A significant amount of development, including that by Dagher [15], went into producing a coupon geometry and test method to achieve representative test data resulting in a procedure following ASTM D3039 with a modified coupon geometry. Prior to this development, test data for tensile strength of laminates was much lower than that predicted of braided laminate.

Data were collected to compare the coefficient of variation (COV) of the tensile testing data from several coupons used in highway bridges throughout the United States using the hybrid composite arch bridge system. Goslin [17], presented a weighted average of the test data resulted in a COV of approximately 11.7%. Data for other structural materials were not collected, however it is believed with this COV, the hybrid composite arch bridge system has a similar need for the number of samples for quality assurance testing as other materials.

5 Recommended Guidelines

Literature and documents were reviewed and led to the recommendations for quality assurance given here. Many of these recommendations are already in place for the hybrid composite arch bridge system. Recommendations are presented covering the Quality Control Plan (QCP) and use of a Quality Control Inspector (QCI) as well particular test sampling for quality assurance testing.

5.1 Quality Control Plan and Quality Control Inspector

Each project currently requires a Quality Control Plan and uses Inspectors during the manufacturing process. These practices follow current industry standards and should continue. The QCP should continue to include the following,

- Procedures for documenting material inventory
- Procedures for the manufacturing process including inspection of critical tasks
- Roles and responsibilities of parties involved in the QCP
- Requirements for the equipment used and environment for production
- Requirements for quality assurance testing including sampling procedure and allowable values of strength data

The manufacturing process includes several critical tasks. These tasks are included in the current QCP for inspection during the production process and should remain. These tasks include,

- Fabric layup including tensioning of the fabric
- Vacuum drop test
- Resin promotion
- Infusion
- Finishing

Quality assurance samples coupons are currently cut from the ends of each of the tubular arches. Test samples described in Dagher [15] are flat and samples developed to date are required to be flat to fit into existing test apparatus. Therefore the round tubes are flattened at the ends creating a section of the tube that can be cut out for tension testing. Current practice is to produce 6 to 8 samples per each end of the tubular arch and prepare 2 test specimens per arch for tension testing. This number of samples agrees well with the number of samples per lot discussed in the previous section and it is recommended that this same practice continue.

Minor changes are recommended for samples that do not meet the design strength required. It is recommended that a minimum strength value be given for test specimens where additional randomly selected specimens can be tested for those specimens that do not meet the design criteria. Currently if samples do not meet the design criteria 8 additional samples are tested to qualify the arch for use and the total number of test samples is used to compare with the design criteria. The addition of this minimum value would agree with the practice in ASTM A615 Section 14.

Current practice is to produce and test only samples in the longitudinal direction. The hybrid composite arch bridge system can also see failures in the hoop reinforcement for arches with relatively high levels of reinforcement in the longitudinal direction and larger diameters as described by Goslin et al [16]. The feasibility of producing and testing specimens for the quality assurance of materials in the hoop direction should be investigated for this reason.

In summary the following recommendations are made for the hybrid composite arch bridge system.

1. Continue with current practices in use for the Quality Control Plan
2. Continue use of Quality Control Inspectors trained in FRP materials
3. Use two specimens per tubular arch for quality assurance testing
4. Add minimum value for or deviation from historical test results and/or design values where additional random samples are allowed to be used for quality assurance testing
5. Investigate the need for quality assurance testing of coupons in the hoop direction for highly reinforced arches in the longitudinal direction

6 Composite Arch Bridge System Training Recommendations and Documentation

The Hybrid Composite Bridge System is a concrete arch bridge system with unique reinforcing materials. Similar to other concrete bridge members the concrete is used in compression and the fiber reinforcement provides tensile reinforcement. In addition this system provides confinement and protection to the concrete for added ductility and durability. This basic understanding will allow the structural engineer to understand the basic mechanics of the hybrid arch bridge system. In depth understanding can come with additional understanding of braided fabrics, the vacuum infusion process and buried arch structures. Additional understanding of composites can be found in the ACMA Composites Lab website (http://compositeslab.com/ or linked from www.acmannet.org).

6.1 Certified Composite Technician-Vacuum Infusion Process

The vacuum infusion process is presented in training for American Composites Manufacturing Association's (ACMA) Certified Composite Technicians in the Vacuum Infusion Process (CCT-VIP). Inspectors of the hybrid composite arch bridge system should have the understanding of the material in this certification. Highlights of that program are listed in the following.

Applicable Highlights of the CCT_VIP Program

- **General Composites Knowledge**
  - Why Composites are Different
- **Composites Manufacturing Processes**
  - Overview
  - Closed Molding
- **Composites Materials**
- **Quality Control and Troubleshooting**
- **Vacuum Infusion**
- **Gel Coats**
- **Vacuum Infusion Process**
  - Overview of VIP Methods and Techniques
  - Vacuum Infusion Theory
  - Physics of the VIP processes: Darcy's Law
- **VIP Best Practice Rules**
- **VIP Equipment: Tools of the Trade**
  - Vacuum Systems
  - Molds for VIP
- **VIP Quality Control and Troubleshooting**
  - Procedural Quality Control for VIP
  - Quality Methods for VIP
  - Part Inspection and Post-Process Verification

6.2 Documentation

Documentation has been created by suppliers of the hybrid composite arch bridge system that adequately documents the quality assurance procedures and QCP that is presently in place. Revisions would be required to address the recommendations presented here should they be accepted. Examples of these forms are presented in Appendix A.

7 References

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16. Goslin K., Walton H., Davids D., Lopez-Anido, R. (2011). Bridge-in-a-Backpack: Task 1: Investigations of Span Lengths up to 70 Feet. Orono, ME: University of Maine.

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Appendix A – Documentation Examples

QA/QC Forms and Records

ADVANCED INFRASTRUCTURE TECHNOLOGIES

Approved for Public Release

Advanced Infrastructure Technologies
20 Godfrey Drive
Orono, ME 04473

AIT QA/QC Forms and Records Revision History

Form	Revision History	
Material Receiving Form	Initial	5/6/2010
	1.0	5/19/2010
Incoming Reinforcement Inspection Form	Initial	5/6/2010
	1.0	5/19/2010
	2.0	9/14/2010
Incoming Resin Inspection and Promotion Form	Initial	5/6/2010
	1.0	5/19/2010
	2.0	9/14/2010
Formwork Data Form	Initial	7/12/2010
Material Storage Form	Initial	5/6/2010
	1.0	5/19/2010
	2.0	9/14/2010
Production Data Form 12"	Initial	5/6/2010
	Initial B	5/14/2010
	1.0	5/19/2010
	1.1	5/26/2010
	1.2	6/22/2010
	1.3	7/12/2010
	2	9/14/2010
Production Data Form 15"	Initial	8/2/2010
	1	9/14/2010
Final Inspection Form	Initial	5/7/2010
	1.0	5/19/2010
	2.0	9/14/2010
Training Form	1.0	5/7/2010
Equipment Calibration Form	1.0	5/7/2010
	Discontinued	9/14/2010
Non-Conforming Materials Form	1.0	5/7/2010
Corrective Action Report	1.0	5/7/2010

DO NOT USE THIS FORM IF IT DOES NOT BEAR A RED "APPROVED" STAMP OR CONTAIN ALL PAGES

MATERIAL RECEIVING FORM

Complete one form for each shipment of project specific material: Bladders, catalyst, and flow media

Work Order: ____________________
Name of Inspector: ____________________
Date of inspection: ____________________
Date of receipt: ____________________
PO Number ____________________
Product Description: ____________________
Quantity Received: ____________________
Quantity Back-ordered: ____________________

Visual inspection:	Acceptable	Unacceptable	Comment
Original undisturbed packaging?			

If unacceptable refuse shipment or label "DO NOT USE" and store away from approved materials

Post Inspection Checklist

- ☐ Write on box with permanent marker the *Date Received* and *Job Number* and *"Approved"*
- ☐ Place material in the designated storage area
- ☐ Deliver completed form, certificate of conformance, and packing slip to management

The following materials require a certificate of conformance
- Cobalt
- DMA
- Styrene
- Trigonox

DO NOT USE THIS FORM IF IT DOES NOT BEAR A RED "APPROVED" STAMP OR CONTAIN ALL PAGES

INCOMING REINFORCEMENT INSPECTION FORM

Complete one form for each box/spool of reinforcement

Work Order: ______________________

PO Number ______________________

Name of Inspector: ______________________

Date of receipt: ______________________

Date of inspection: ______________________

Item Number (e.g.: UM6447) ______________________

Total Spool Quantity ______________________ LB total

For each length of fabric record the following info:

	CIN# (e.g.: CIN1-091017-003)	Length (ft)	Weight (lbs)	Notes
1				
2				
3				
4				

write the CIN numbers on the spool

Visual inspection:	Acceptable	Unacceptable	Comments
Original undisturbed packaging?			
Clean?			
Correct color?			
Dry to touch?			
Free from any contamination?			
Certificate of conformance included?			

Post Inspection Checklist

- [ ] Write on box/spool with permanent marker the *Date Received, Job Number, CIN#,* and *"Approved"*
- [ ] Place reinforcement in the designated storage area
- [ ] Deliver completed form, certificate of conformance, and packing slip to project manager

AIT Incoming Reinforcement Inspection Form 4 of 12 Rev. 2.0 - 9/14/2010

DO NOT USE THIS FORM IF IT DOES NOT BEAR A RED "APPROVED" STAMP OR CONTAIN ALL PAGES

INCOMING RESIN INSPECTION AND PROMOTION FORM

(one form per barrel of resin)

Work Order: ______________________

Date of receipt: ______________________

Date & time of inspection: ______________________

Name of Inspector: ______________________

Vendor's name: ______________________

Resin's Trade name: ______________________

Date of Manufacture: ______________________

Batch Number: ______________________

Inspection and Promotion

Pour Bung Seal: ☐Broken ☐Unbroken

If broken is the barrel labeled as promoted? ☐Yes ☐No

Surface temperature of drum: __________ °F (must be ≥60°F but ≤85°F)

□ Measure out appropriate promotion ingredient amounts and get approval before proceeding

Promotion	Batch #	Schedule	Actual
Resin:		oz	oz
Cobalt, 6%:		ml	ml
DMA:		ml	ml
2,4-P:		ml	ml
Additional Styrene		ml	ml

Production Manager approval for promotion schedule ______________________
signature

------------------------------------DO NOT PROCEED WITHOUT APPROVAL------------------------------------

Actual mix times

□ Remove bung caps

□ Agitate drum with electric mixer for at least 30 minutes --: __________

□ Place about 40 lbs of the resin in a clean 5gal. bucket

□ Add promotion chemicals to bucket and mix with a mechanical mixer for 2-3 minutes----------: __________

□ Return contents of the 5gal. bucket back into the drum

□ Mix for an additional 15 minutes with electric mixer --: __________

□ Label drum with promotion date, worker name, job number, and promotion ingredient amounts

Viscosity Test

Zhan cup model: ______________________

Number of seconds in the Zhan cup:

Trial 1 __________ seconds

Trial 2 __________ seconds

Trial 3 __________ seconds

AIT Incoming Resin Inspection and Promotion Form
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Rev. 2.0 - 9/14/2010

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Gel Time Test (this step is not required if the resin batch has been previously gel time tested)

Has the batch been previously gel time tested? ☐ Yes ☐ No

Size of test sample ________________ grams

Catalyst	Batch #	Schedule	Actual
Trigonox	________________	________________ g	______________ g

Total mixing time: ________________ seconds
(1 minute minimum)

Gel Time: ________________

NOTE: Consult Project Manager regarding appropriate promotion and catalyst recipe

Production Manager's Acceptance: ________________________________
signature

Quality Assurance Representative Acceptance: ________________________________
signature

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MATERIAL STORAGE CONDITIONS FORM

Complete one form for each project
To be completed by QAR

Work Order #: ____________________
AIT Project #: ____________________
Date: ____________________

Reinforcement

Provide a description of the reinforcement storage condition and attach photos

____
____
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____

Resin

Provide a description of the resin storage condition, attach photos, and temperature records

____
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____
____
____
____

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Final Inspection Form

Inspection Date: ____________________
Inspected by: ____________________ Quality Assurance Representative
Work Order: ____________________
AIT Project #: ____________________
Part Number/Label: ____________________

Diameter
Measure diameter of arch in ten equally spaced locations on the arch with a pi tape to within 1/64" or 0.01"

Nominal	11.80	inches
Tollerance	±0.2	inches
Minimum	11.60	inches
Maximum	12.00	inches

1		inches	6		inches
2		inches	7		inches
3		inches	8		inches
4		inches	9		inches
5		inches	10		inches

Average ________ inches

Diameter measurements within tollerances? ☐Yes ☐No

Span
Measure the span from locator hole to locator hole with no external force applied to arch

Target Span		ft-decimal inches
Tollerance	±1.5"	inches
Minimum Span		ft-decimal inches
Maximum Span		ft-decimal inches
Span		ft-decimal inches
Difference		inches

Span measurement within tollerances? ☐Yes ☐No

Rise
Measure rise from top of crown to line between locator holes

Target Rise		ft-decimal inches
Tollerance	±1"	inches
Minimum Rise		ft-decimal inches
Maximum Rise		ft-decimal inches
Span		ft-decimal inches
Difference		inches

Rise measurement within tollerances? ☐Yes ☐No

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Defects

Visually inspect the entire arch looking for any defects such as dry fiber or excessive wrinkling of the fabric
There shall be no voids larger than 1/8" and no areas of excessive porosity caused by mold leaks

Comments

____
____
____
____
____
____

Is the part free of defects? ☐Yes ☐No

Machining and Finishing

Are the ends cut to the dimensions shown on the shop drawings? ☐Yes ☐No

Does the part contain the ID card laminated into the finish coat? ☐Yes ☐No

Does the finish coat cover all parts of the arch? ☐Yes ☐No

Are all vent/fill holes shown on the drawings machined? ☐Yes ☐No

____
Quality Assurance Representative Signature

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Training Record

Name:
Position:
Date of Training:
Description of Training:

Name:
Position:
Date of Training:
Description of Training:

Name:
Position:
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Description of Training:

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Description of Training:

Quality Assurance Representative Signature

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Non-Conforming Materials Form

Item:
Identification Number:
Date Discovered:
Description of Non-conformity:

Item:
Identification Number:
Date Discovered:
Description of Non-conformity:

Item:
Identification Number:
Date Discovered:
Description of Non-conformity:

Item:
Identification Number:
Date Discovered:
Description of Non-conformity:

Item:
Identification Number:
Date Discovered:
Description of Non-conformity:

Item:
Identification Number:
Date Discovered:
Description of Non-conformity:

Item:
Identification Number:
Date Discovered:
Description of Non-conformity:

Quality Assurance Representative Signature

Corrective Action Report Form

Date: ______________ **Initiated by:** ______________

Participants in the corrective action investigation:

Description of the need for corrective action:

Description of the root causes of the event:

Description of the corrective action to be taken:

Result of the corrective action (possibly completed at later date):